Fish Passage at Road Crossings Assessment Caribou-Targhee National Forest FY 2005

By
Corey A. Lyman, Fishery Biologist
Caribou-Targhee National Forest

EXECUTIVE SUMMARY

Inventory

The Fish Passage at Road Crossings Project for FY 2005 on the Caribou-Targhee National Forest evaluated 330 road/stream crossings and completed full culvert inventory assessments on 86 of those crossings on fish-bearing streams (Table 1). The Caribou-Targhee National Forest survey crew completed 244 partial assessments to collect basic descriptive data on any crossing that did not warrant a full inventory (i.e. bridges, fords, and inaccessible culverts located on private lands). Information on crossing types that were partially assessed can be found in Table 12. The total number of road crossings on fish-bearing streams across the Forest is estimated to be 1080 (Table 2). Of the 86 complete assessments that were rated twice (for juvenile and adult passage requirements) 77% of these crossing sites do not meet the criteria to pass fish (RED), and are a barrier for at least one life stage (Table 1). Of the 86 crossings surveyed 73% were a barrier to adults and 81% were found to be a barrier to juveniles (Table 1). Most of the "RED" crossings were associated with circular culverts (Table 3). Most of the "RED" crossings were a barrier at least due to the outlet drop (Table 11) but, if further evaluated, may also be a barrier for other reasons. Of the 86 complete assessments that were rated twice (for juvenile and adult passage requirements) only 8% of the culverts evaluated met the passage criteria and were not a barrier (GREEN) to at least one life stage. Of the 86 crossings surveyed 12% were not a barrier to adults and less than 4% were found not to be a barrier to juveniles (Table 1). Seven of the ten crossings that ranked Green for adults were considered to be impassable for juveniles. These crossings included eight circular culverts, and two squashed pipe-arch culverts. The remaining 15% of the 86 complete assessments that were rated twice (for juvenile and adult passage requirements) were found to be undeterminable (GREY) and candidates for further evaluation (e.g.; Fish Xing software).

Table 1: Summary of Aquatic Organism Passage Barriers

Lifestage	RED	GREY	GREEN	Total
Adult	**63**	**13**	**10**	**86**
Juvenile	**70**	**13**	**3**	**86**

Red = is a barrier to fish. GREY = is unknown and requires further assessment to determine passability. Green = is passable to these life stages of fish. As seen in the table, of the 181 crossings inventoried, a large majority (90%) were found to be barriers to all life stages of fish.

Table 2: Summary of Priority Crossings Inventoried and those Estimated to be Remaining

Priority	# Crossing Sites Done	# Crossing Sites Remaining
BCT and YCT stronghold streams	**38**	**0**
303(d) listed streams	**35**	**0**
BCT and YCT strongholds on 303(d) streams.	**13**	**0**
All other streams	**0**	**1080**
Total	**86**	**1080**

This table summarizes the accomplishments of the Forest culvert survey crew during the 2005 field season per priority areas. On the Caribou-Targhee National Forest, Yellowstone and Bonneville cutthroat trout were identified as the species of concern. Streams with known cutthroat strongholds were identified and surveys were completed as the 1st priority. Stronghold streams were defined as those streams where the salmonid community consisted of at least 50% native cutthroat. Connectivity was also considered as an important stronghold characteristic. Distribution and population data from the last 8 years were used to determine stronghold designations. Additional culvert surveying priority was given to streams that were Idaho and Wyoming as water quality impaired streams (303(d)). In the future, additional surveys could be conducted on all other fish bearing streams.

This report summarizes the prioritization of sites, the methods and assumptions, the evaluation criteria, the results, and a proposal for rehabilitation or reconstruction. For a more detailed description of the results by Hydrologic Unit Code (HUC) or stream, refer to the appendices. All of the assessments, whether full or partial, are summarized by 4th HUC subbasins and 5th field watersheds in Appendix A. All full assessments are also detailed by 5th field watersheds in Appendix B and displayed (mapped) in Appendix C.

Inventory Results

The majority of culverts (73% for adults and 81% for juveniles) in the thirty-six 5th HUC watersheds surveyed rated out in the "RED" category (Table 1, Appendix A). All of these barriers were found to be circular or squashed pipe-arch culverts (Table 3).

Recommendations

We have taken these results and focused on those crossings considered "RED" for one or both life stages. Priority was assigned mainly by calculating the miles of habitat available upstream from the crossing. All passage data displayed and utilized in this report were based upon field evaluations versus using the Fish Pass database results. This decision was made due to database inconsistencies with calculating bankfull to structure widths at dual culverts. Prioritization of culverts was divided into three lists, according to cutthroat trout stronghold and water quality status (Tables 4, 5, and 6). Note that some crossings are listed in multiple tables because some streams are both cutthroat strongholds and impaired waters (303(d)). The Caribou-Targhee National Forests Fishery Biologists also asked the following questions to verify that these crossings were located in areas considered to be priorities for restoration.

Table 3: Crossing Type Designations by Lifestage and Passability

Crossing Type	Adult Red	Juvenile Red	Adult Grey	Juvenile Grey	Adult Green	Juvenile Green
Circular	54	60	11	12	8	1
Pipe-Arch	9	10	2	1	2	2
Total	**63**	**70**	**13**	**13**	**10**	**3**

This table represents a summary of the types of crossings (mainly culverts) that were encountered during the full crossing assessment. The majority of crossings inventoried (85%) were circular culverts. One reason for this is that most of the other types of crossings, like bridges and fords were identified as non priorities for full passage assessments.

- Does important habitat occur upstream of the culvert?
- How many miles would be made accessible if passage was restored?
- Will correction of this barrier make the stream more accessible to non-native species?

The order within Tables 4, 5, and 6 is based upon the amount of perennial stream habitat upstream. Note that some perennial stream miles may not necessarily provide suitable fish habitat, but may provide habitat for other aquatic-dependent species. All culvert replacement projects should occur with interdisciplinary coordination. A Fisheries Biologist should be consulted prior to planning the removal of any upstream migration barrier. Professional Fisheries staff will need to evaluate existing fish distribution data or conduct new presence/absence monitoring if nonnative fish are present in the watershed to determine appropriate actions to be taken at barrier crossings. As a result of this consultation some culverts deemed "Red" may require no passage restoration activities to benefit the

fisheries resource. Crossings that contain dual culverts with mixed passage ratings should also be analyzed by a fisheries biologist to determine if restoration activities are warranted.

The survey methodology developed by San Dimas is very conservative. It must be, to account for the abilities of most migratory aquatic biota found in the National Forest System to migrate upstream. The participation of Cariobu-Targhee National Forest Fisheries Biologists in the selection of culvert replacement projects from the priority list in this document will be important to account for the conservative analysis method required.

The cost of replacement is based on an average cost for replacing similar-sized culverts with open-bottom arches. Based on past and current replacements on other southern Idaho Forests, construction and supplies alone average approximately $60,000. Planning costs are added to the construction and supply cost to estimate the total cost. However, some culvert replacements will cost substantially more than this average. For example, the Trout Creek culvert replacement (FS102-2.8) utilized a culvert pre-fit with weirs to account for channel instability while allowing upstream migration of fish. Other replacement scenarios may require a very wide replacement structure, such as a bridge, to span the bankfull width, resulting in costs 4-5 times higher than the average described above.

Caribou-Targhee National Forest personnel worked with contractors to replace Targhee Creek, Howard Creek, Garden Creek and Trout Creek culverts in 2005. The Burns Creek culvert (FS087-1.7) is scheduled for replacement in 2006.

We recommend continuing the inventory across the Forest to obtain data on all other streams that were not considered as priorities during this survey effort (stronghold or 303(d) streams), when funding is available. As illustrated in Table 2, the Caribou-Targhee National Forest has over 1080 stream crossings that have not been assessed. The results to date provide a compelling reason to evaluate the remaining crossings for all species, regardless of priority, because the data is a precursor to restoration of connectivity for other species of concern, including other native fish, amphibians, and macroinvertebrates.

Table 4: Bonneville Cutthroat Trout Priority Sites for Culvert Replacement on the Caribou-Targhee National Forest

Forest-wide Priority based on 2003 & 2004 San Dimas Aquatic Organism Passage Inventory Protocol Results

HUC 5 Code	Stream Name	Crossing ID	Inventory Priority	Lifestage Affected by Crossing	Miles of Blocked Habitat Upstream	Perennial Miles Upstream
1601010205	Pruess Creek	FS111-5.1	BCT+303(d)	Juveniles	2.62	2.62
1601020103	South Skinner Creek	FS403-1.0	BCT	Both	0.38	0.38

Table 5: Yellowstone Cutthroat Trout Priority Sites for Culvert Replacement on the Caribou-Targhee National Forest

Forest-wide Priority based on 2003 & 2004 San Dimas Aquatic Organism Passage Inventory Protocol Results

HUC 5 Code	Stream Name	Crossing ID	Inventory Priority	Lifestages Affected by Crossing	Miles of Blocked Habitat Upstream	Perennial Miles Upstream
1704010509	Tincup Creek	HWY34-3.3	YCT	Both	24.35	24.35
1704010409	Elk Creek	FS058-1.9	YCT+303(d)	Both	12.87	12.87
1704020409	Horseshoe Creek	FS175-0.10	YCT+303(d)	Both	11.93	18.13
1704020409	Horseshoe Creek	FS175-0.11	YCT+303(d)	Grey - Not determined	11.93	18.13
1704010509	Tincup Creek	HWY34-5.30	YCT	Both	11.79	40.02
1704010509	Tincup Creek	HWY34-5.31	YCT	Both	11.79	40.02
1704010411	McCoy Creek	FS087-0.1	YCT+303(d)	Both	11.76	11.76
1704021503	Crooked Creek	FS178-2.8	YCT	Both	9.15	9.15
1704010406	Indian Creek	FS161-0.01	YCT	Both	6.78	6.78
1704010410	Trout Creek***	FS087-3.5	YCT	Both	6.33	6.33
1704010500	Burns Creek	FS087-1.7	YCT	Both	5.27	5.27
1704021505	North Fork Fritz Creek	FS195-1.0	YCT	Both	5.01	5.01
1704020802	East Fork Mink Creek	FS524-0.1	YCT	Both	4.64	4.64
1704010401	Wolverine Creek	FS206-1.10	YCT	Both	3.67	3.67
1704010401	Wolverine Creek	FS206-1.11	YCT	Both	3.67	3.67
1704021404	West Fork Rattlesnake Cr.	FS021-1.5	YCT	Both	3.57	3.57
1704020409	North Fork Horseshoe Cr.	FS802-0.05	YCT+303(d)	Both	3.51	6.20

1704010509	Tincup Creek	HWY34-5.80	YCT	Both	3.41	43.43
1704010509	Tincup Creek	HWY34-5.81	YCT	Both	3.41	43.43
1704020208	West Dry Creek Trib	FS327-4.0	YCT	Both	3.19	3.19
1704010401	Table Rock Creek	FS217-1.8	YCT	Both	3.07	3.07
1704010510	Deep Creek	FS070-0.7	YCT	Juveniles	2.81	6.90
1704010411	Miners Delight	FS087-3.1	YCT	Both	2.28	2.28
1704020804	Goodenough Creek	FS541-2.90	YCT+303(d)	Both	2.09	2.09
1704020804	Goodenough Creek	FS541-2.91	YCT+303(d)	Both	2.09	2.09
1704010507	Deer Creek	FS102-1.3	YCT	Both	1.92	1.92
1704020409	North Fork Horseshoe Cr.	FS235-1.7	YCT+303(d)	Both	1.88	2.69
1704010510	Deep Creek	FS070-1.4	YCT	Both	1.81	3.82
1704010401	Table Rock Creek	FS217-0.01	YCT	Juveniles	1.73	4.80
1704010510	Deep Creek	FS070-3.3	YCT	Both	1.50	1.50
1704010508	Flat Valley Creek	FS107-6.6	YCT	Both	1.37	1.37
1704020212	Howard Creek	FS057-0.01	YCT+temp	Both	1.25	1.25
1704021506	Corral Creek	FS323-0.10	YCT	Both	0.86	1.12
1704021506	Corral Creek	FS323-0.15	YCT	Both	0.86	1.12
1704020409	North Fork Horseshoe Cr.	FS235-2.4	YCT+303(d)	Both	0.73	0.73
1704021404	Corral Creek	FS177-0.25	YCT	Both	0.62	0.62
1704020210	Tygee Creek	FS061-6.9	YCT	Both	0.35	0.35
1704010510	Deep Creek	FS070-1.1	YCT	Both	0.27	4.09
1704021506	Corral Creek	FS323-1.0	YCT	Both	0.26	0.26
1704010509	Tincup Creek	HWY34-3.5	YCT	Both	0.23	24.58
1704020409	North Fork Horseshoe Cr.	FS235-2.5	YCT+303(d)	Both	0.08	0.81
***Trout Creek culvert was surveyed and replaced within the summer of 2005, no further action required.						

Table 6: Water Quality Impaired - 303(d) Priority Sites for Culvert Replacement on the Caribou-Targhee National Forest

Forest-wide Priority based on 2003 & 2004 San Dimas Aquatic Organism Passage Inventory Protocol Results

HUC 5 Code	Stream Name	Crossing ID	Inventory Priority	Lifestages Affected by Crossing	Miles of Blocked Habitat Upstream	Perennial Miles Upstream
1704010409	Elk Creek	FS058-1.9	YCT+303(d)	Both	12.87	12.87
1704020409	Horseshoe Creek	FS175-0.10	YCT+303(d)	Both	11.93	18.13
1704020409	Horseshoe Creek	FS175-0.11	YCT+303(d)	Grey for Both	11.93	18.13
1704010411	McCoy Creek	FS087-0.1	YCT+303(d)	Both	11.76	11.76
1704020802	Mink Creek	FS515-0.15	303(d)	Both	9.06	9.06
1601020105	Montpelier Creek	FS149-0.1	303(d)	Juveniles	8.92	16.27
1601020105	Montpelier Creek	US89-0.01	303(d)	Both	7.35	7.35
1704020402	North Moody Creek	FS256-0.40	303(d)	Both	6.87	6.87
1704020402	North Moody Creek	FS256-0.45	303(d)	Both	6.87	6.87
1601020104	Georgetown Creek	FS102-2.8	303(d)	Both	6.52	6.52
1704020505	Corral Creek	FS086-0.01	303(d)	Juveniles	3.59	3.59
1704020409	North Fork Horseshoe Cr.	FS802-0.05	YCT+303(d)	Both	3.51	6.20
1601020106	North Creek	FS401-0.40	303(d)	Grey for Juveniles	3.28	7.40
1601020106	North Creek	FS401-0.41	303(d)	Both	3.28	7.40
1704020809	North Fork Pebble Creek	FS036-1.3	303(d)	Juveniles	3.16	4.25
1704020212	South Fork Duck Creek	FS053-2.8	303(d)	Both	2.93	2.93
1601020105	Snowslide Canyon	FS111-3.8	303(d)	Both	2.85	2.85
1601020303	Beaver Creek	FS411-0.15	303(d)	Juveniles	2.83	2.83
1601010205	Pruess Creek	FS111-5.1	BCT+303(d)	Juveniles	2.62	2.62
1601020303	Beaver Creek	FS411-3.3	303(d)	Both	2.55	5.95
1704020804	Goodenough Creek	FS541-2.90	YCT+303(d)	Both	2.09	2.09
1704020804	Goodenough Creek	FS541-2.91	YCT+303(d)	Both	2.09	2.09
1601020102	Eightmile Creek	FS402-0.1	303(d)	Both	1.95	6.75
1704020409	North Fork Horseshoe Cr.	FS235-1.7	YCT+303(d)	Both	1.88	2.69
1704020809	Pebble Creek	FS024-0.5	303(d)	Both	1.80	1.80
1601020106	North Creek	FS000-0.1	303(d)	Both	1.64	9.04
1704021503	Warm Spring Creek	FS198-1.0	303(d)	Both	1.40	1.40

1704020212	Howard Creek	FS057-0.01	YCT+temp	Both	1.25	1.25
1704021503	Warm Spring Creek	FS198-0.1	303(d)	Both	0.90	2.30
1704020409	North Fork Horseshoe Cr.	FS235-2.4	YCT+303(d)	Both	0.73	0.73
1601020303	Beaver Creek	FS411-0.75	303(d)	Both	0.57	3.40
1704021403	Cow Creek	FS678-0.20	303(d)	Both	0.55	0.55
1704021403	Cow Creek	FS678-0.21	303(d)	Both	0.55	0.55
1601020108	Paris Creek	FSPSC-1.4	303(d)	Both	0.36	0.36
1601020106	North Creek	FS401-2.5	303(d)	Both	0.31	3.80
1601020106	North Creek	FS401-2.2	303(d)	Both	0.21	4.12
1601020106	North Creek	FS401-2.4	303(d)	Both	0.11	3.91
1704020409	North Fork Horseshoe Cr.	FS235-2.5	YCT+303(d)	Both	0.08	0.81

Inventory Procedure Discussion

Initial Prioritization of Sites

Upon learning that the Caribou-Targhee National Forest would be funded for culvert assessment in FY2005, the Forest Fisheries Personnel determined where to prioritize survey efforts. The Forest Team first focused on those subbasins that contained native cutthroat trout. On the Caribou-Targhee National Forest the native cutthroat trout subspecies were the Bonneville (BCT) and Yellowstone Cutthroat trout (YCT). BCT and YCT are listed as Sensitive by Region 4 of the U. S. Forest Service (see Table 7) and as a Species of Special Concern by the State of Idaho. On the Caribou-Targhee National Forest BCT and YCT are widely distributed across the Forest with varying degrees of population viability. Population data were utilized to determine which streams supported abundant numbers of the key species. These streams that contained over 50% BCT and YCT were determined to be stronghold populations, requiring culvert survey efforts. In addition to surveying streams that contained stronghold populations of the key species, the Forest Hydrologist requested we survey water quality impaired streams (303(d)). Analysis of problem culverts on listed streams (303(d)) could generate positive effects for fish populations, channel stability, and water quality. We then determined how many stream crossings occurred in fish-bearing streams within these selected subbasins by using GIS stream and road coverages. Perennial streams were intersected with roads to estimate the number of potential survey sites. The fisheries group reviewed maps displaying this information to help verify which crossings were bridges, fords, or culverts. This provided a starting point for the surveys. Further field verification confirmed the presence of bridges, fords, and culverts.

Table 7. Sensitive and Idaho State Special Concern Fish Species Present on the Caribou-Targhee National Forest.

Fish Species	Status	HUC 4 Subbasin							
		Medicine Lodge	Beaver-Camas	Upper Henrys	Teton	Palisades	Salt	Blackfoot	Portneuf
Yellowstone Cutthroat Trout (YCT)	Sensitive and Idaho State Species of Special Concern	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Fish Species	Status	HUC 4 Subbasin							
		Bear Lake	Central Bear	Little Bear-Logan	Willow				
Bonneville Cutthroat Trout (BCT)	Sensitive and Idaho State Species of Special Concern	**X**	**X**	**X**	**X**				

Field Crews and Inventory Collaboration

The Caribou-Targhee National Forest utilized one two person crew to conduct the field surveys during FY2005. Crew production was tracked by fisheries biologists throughout the season to maintain crew production and data quality. The crew was given the responsibility for determining what sites warranted a full inventory and a professional fisheries biologist verified this decision. At sites that did not warrant a full inventory, tertiary information such as GPS locations, type of structure present, and field notes concerning the stream reach were collected to assemble partial assessments. The partial assessment provided the Forest with information on stream crossings that were not culverts, crossings that were not accessible (located on private land), and crossings located on non fish bearing reaches. This information will be used as an aid in future analysis documents to evaluate stream connectivity and interactions between the road and stream systems. A summary of full and partial crossing assessment counts is located in Table 10.

Additional Methods & Assumptions
Evaluation Criteria

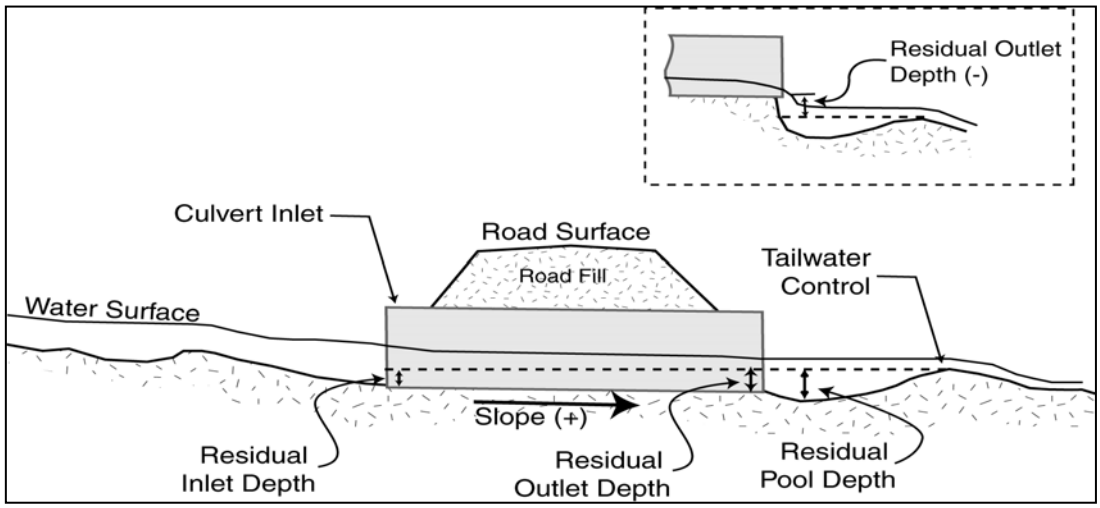
The USFS Region 1 fish passage evaluation criteria screening process was used to classify existing crossings as meeting, needing further hydraulic analysis, or failing to meet fish passage criteria for selected resident fish species. Region 1 constructed two flow charts (Figures 1 and 2), similar to ones developed by the California Department of Fish and Game (2001), for juvenile and adult cutthroat and bull trout. These flowcharts attempt to define whether passage is provided through existing structures at the time of survey.

The regional passage evaluation criteria flowcharts first determine whether the crossing meets natural channel simulation criteria. It is important to remember that these evaluation criteria are not as rigorous as stream simulation DESIGN criteria. Criteria for evaluating natural channel simulation include:

- Streambed substrate is continuous in character and profile throughout the entire length of structure (Representative bed material must be arranged in a stable configuration that provides for flow diversity, energy dissipation, and continuity of bedload transport throughout the structure).
- Crossing is set at or below stream grade – no outlet perch (No perch is assumed if streambed substrate is continuous throughout the structure).
- Structure width is equal to or greater than the average bankfull width of the channel out of the influence of the crossing – no constriction of the active channel exists.
- No steep drops occur immediately upstream of structure – channel slope between the crossing inlet and the first upstream holding habitat is similar to overall channel gradient (This must be verified for all crossings initially considered passable from the screen).

If the site inventory data verifies the above natural channel simulation criteria, the crossing is considered adequate for passage of all salmonids, including the weakest swimming life stage. If not, one proceeds through the flowcharts to further evaluate each culvert until a passage status is determined. These criteria can be viewed in three stages:

1. getting into the culvert,
2. getting through the culvert,
3. and getting out of the culvert.



Residual Pool Depth = (Elev $_{\text{Tailwater Control}}$ – Elev $_{\text{Pool Bottom}}$)
Outlet Drop = (Elev $_{\text{Tailwater Control}}$ – Elev $_{\text{Outlet Invert}}$)
Residual Inlet Depth = (Elev $_{\text{Tailwater Control}}$ – Elev $_{\text{Culvert Inlet}}$)
Culvert Slope Percent = (Elev $_{\text{(Inlet Invert – Outlet Invert)}}$ / Dist $_{\text{(Inlet Invert – Outlet Invert)}}$ X 100)
Inlet Gradient = (Elev $_{\text{(Inlet Gradient Control Point – Inlet Invert)}}$ / Dist $_{\text{(Inlet Gradient control Point – Inlet Invert)}}$ X 100

Figure 3. Measurements used in evaluation criteria (from Taylor and Love, 2001).

Getting into the Culvert
Outlet Drop

Culvert outlets that are perched above the water surface are common obstacles to fish passage. Perch height is flow-dependent. Therefore, the stream discharge at the time of the field assessment does not provide for a comprehensive measurement of perch height. The Region 1 protocol uses a conservative assessment of perch height by comparing the outlet invert elevation to the tailwater control elevation (Figure 3). This is a flow-independent measurement. Ideally, the perch height should be evaluated at various discharges up to the high-flow design discharge. However, this would be too time-consuming for this comprehensive assessment of all culverts in the region.

Based on literature review and consultation with fisheries biologists, which is also documented in this section, the following screening criteria were utilized to evaluate culvert outlets (Table 8).

Table 8. Culvert Outlet Screening Criteria.						
	GREEN (juvenile)	**GREEN (adult)**	**GREY (juvenile)**	**GREY (adult)**	**RED (juvenile)**	**RED (adult)**
Culvert Outlet	Not perched plus culvert backwatered at least 0.5'	Perch ≤ 0.5' plus culvert backwatered at least 0.5'	Perch 0-0.34' plus outlet pool depth at least 1.25 times perch height	Perch 0-0.8' plus outlet pool depth at least 1.25 times perch height	Perch > 0.34'	Perch > 0.8'
			Note: Hydraulic analysis required to determine passability.			

Through biological monitoring, fish have been observed jumping considerable vertical and horizontal distances to clear obstacles. However, few studies have actually documented the jumping ability of fish, especially for young and small fish. Lab studies have determined that ideal jumping conditions for fish occur when the ratio of the jump height to the depth of the pool below the jump is 1:1.25 (Robison et al 1999). NMFS SW Region (2001) states that culvert perch needs to be evaluated for both high design flow and low design flow and should not exceed 1 foot for adult fish and 6 inches for juveniles with a jump pool of at least 2 feet. Burton (1998) states in his protocol for assessing fish passage at culverts on the Boise River Basin that the standard maximum jumpable height for adult trout is 0.984 foot (11.8 inches) and 1.968 foot (23.6 inches) for adult salmon. The Idaho Dept of Lands (1998) guidelines for new stream crossing installation permits a maximum drop of 1 foot from the culvert outlet when a holding pool is provided. The USFS R6 and R10 fish passage assessment screening criteria indicate that culverts with an outlet perch height of less than four inches may accommodate upstream movement of juvenile coho salmon, but the crossing is only considered passable (GREEN) when the structure is not perched.

Getting through the Culvert
Culvert Slope

Water velocity within a culvert is determined primarily by culvert length, width, gradient and roughness. If the culvert gradient is too steep, or the culvert width is narrower than the streambed width, the water velocity will be increased within the culvert. Even very slight changes in the slope of the culvert (0.5% to 1.0%, for example) or substrate roughness within the structure may significantly change the culvert velocity.

The Caribou-Targhee National Forest utilized the following screening criteria, developed by the Boise National Forest Fisheries Biologist to evaluate culvert slope (Table 9). This criterion is based on literature review and consultation with fisheries biologists, which is also documented in this section.

Table 9. Culvert Slope Screening Criteria.

	GREEN (juvenile)	GREEN (adult)	GREY (juvenile)	GREY (adult)	RED (juvenile)	RED (adult)
Embedded Culvert	Maximum Gradient ≤1% (unless inlet depth > 0.34') plus Culvert width/ Bankfull width ratio ≥ 0.7 plus No outlet drop	Maximum Gradient ≤2% (unless inlet depth > 0.34') plus Culvert width/ Bankfull width ratio ≥ 0.7 plus Perch ≤ 0.5'	Maximum Gradient ≤1% plus Perch < 0.34' plus Insufficient Backwatering	Maximum Gradient ≤2% plus Perch 0.5-0.8' plus Insufficient Backwatering	Gradient >1%	Gradient >2%
Note: In cases where the residual inlet depth meets the minimum depth criteria, backwatering exists, and there is no outlet perch (or up to 0.5 foot perch for adults), then culvert gradient is automatically allowed to be higher to some degree.			Note: Hydraulic analysis required to determine passability.			

According to Idaho Dept. of Lands (1998), bare culverts greater than 50 ft long will cause fish-passage problems for adult spring-migrating trout (6-12 inches) if installed at over a 0.5% gradient and for juvenile and weak-swimming fish if over 0%, unless properly backwatered. If adequately backwatered, the culvert could be up to 4% gradient for adults and 3% for juveniles and still allow upstream passage. The Idaho guidelines state that culverts without streambed substrate that are less than 50 ft long can be installed up to 1% gradient for adult passage and 0.5% for juvenile passage. NMFS SW Region (2001) new installation guidelines require the slope of a non-embedded culvert to be less than 0.5% for salmon and steelhead. In the USFS Region 6 and 10 passage assessment matrices for juvenile Coho salmon, culvert grade for bare culverts must be less than 0.5% to be considered passable (GREEN). Bare culvert crossings with gradients between 0.5% and 1% would be considered GRAY for juvenile passage and would require hydraulic analysis to determine passability. Pipe arches with less than 100% substrate coverage can have a gradient of up to 2% (GRAY) before being considered non-passable (RED). If the culvert contained 100% substrate coverage of adequate depth (20% of culvert rise), then culvert gradient could be up to 2% in circular culverts with 2x6 corrugations and still be passable (GREEN) and go as high as 4% in that same situation before being considered non-passable (RED). The California Dept of Fish and Game (2001) assessment flowchart determines that culverts with slopes greater than 2% and not adequately backwatered and/or with a perch are considered non-passable (RED) for adult and juvenile anadromous salmonids. Culverts with less than 2% gradient and not adequately backwatered and/or with a perch are considered GRAY, thus requiring hydraulic analysis.

Residual Inlet Depth

Residual inlet depth is the depth of water at the inlet of the structure under no flow (or very low flow) conditions. When the outlet tailwater control elevation is higher than that of the inlet invert, the residual inlet depth will be a positive number and the structure will be backwatered at all flows (Figure 3). This positive depth, i.e. backwatering, is generally conducive to passage of most species and life stages since it tends to reduce velocities within the structure. It is important to note that spring-fed streams may never experience very low flows and therefore maintain ample water depth throughout the structure even without a positive residual inlet depth. The main reasons for setting a minimum residual

inlet depth are to ensure that depth is adequate to allow passage at low flow conditions, and to acknowledge that backwatering may facilitate passage through culverts that are otherwise too steep.

The minimum depth necessary for successful passage depends on fish size, as larger fish require more water for passage. Based on a review of research findings and stream crossing design guidelines, the minimum water depths that allow most adult and juvenile trout to pass through a culvert, range from 0.25 foot (3 inches) to 1 foot (12 inches). For adult steelhead and salmon, the minimum water depth required for passage varies from 0.59 foot to 1 foot. Belford and Gould (1989) found that 0.26 foot (3.12 inches) was a sufficient depth to pass adult trout through the six Montana highway culverts evaluated in their study. The Idaho Department of Lands fish passage manual (1998) sets minimum depth criteria of 0.25 foot (3 inches) during migration. California Department of Fish and Game (1998) has a minimum of 1 foot for adult Chinook and steelhead and 0.5 ft for juvenile salmon and all trout. The Washington Department of Fish and Wildlife (2000) has a design standard minimum depth criterion of 0.8 foot for adult trout and 1 foot for adult Chinook and steelhead. Thompson (1972) found that for successful upstream migration of adult salmon and trout through non-embedded culverts, a minimum water depth of 0.59 foot (7.1 inches) for steelhead and 0.79 foot (9.5 inches) for Chinook is required. The NMFS SW Region (2001) requires a minimum water depth of 1 foot (12 inches) for adult steelhead and salmon and 0.5 foot (6 inches) for juvenile salmon when designing non-embedded culverts. Burton (1998) suggested having a minimum water depth of 0.49 foot (5.9 inches) for adult trout, and 0.984 foot (11.8 inches) for adult salmon on the Boise National Forest. Trout in Virginia were observed maneuvering a minimum depth of flow of 0.29 foot (3.5 inches) (Warren and Pardew 1998).

Getting out of the Culvert
Average Bankfull Width to Inlet Width Ratio

Constriction is addressed at two levels within the flowchart. The first discriminator is found within the natural channel simulation criteria – the culvert width must be equal to or greater than the average bankfull width and have substrate retained throughout the structure. If the crossing meets these criteria, it is not constricting the channel and considered GREEN. Secondly, in all other structures (embedded or non-embedded), the culvert width must be at least equal to 70% (ratio of 0.7) of the bankfull channel width as well as meeting requirements for outlet drop and slope to be categorized as GREEN. If the culvert width is less than 50% (ratio of 0.5) of the average bankfull channel width, it is considered RED for all life stages. In most cases, if a culvert overly constricts the channel, the tailwater control becomes scoured and incised by the higher velocity, backwatering is significantly reduced or eliminated and a perch may or may not form. In other words, if the structure overly constricts the channel, most likely there is an outlet perch as well. Constriction thresholds are based on initial culvert inventory data review and hydraulic analysis for a number of sites in USDA Forest Service Region 1.

Note that for all natural channel simulation crossings and other structures categorized as GREEN, it will still be necessary to review the inlet gradient and identify sites that have a steep drop in the channel profile directly in front of the culvert inlet providing evidence that the crossing does indeed constrict the channel (Evidenced by hourglass shapes that suggest velocities within the structure are higher than that of the stream channel). This steep slope can be a migration barrier to both adult and juvenile fish, because it creates supercritical flow just inside the inlet. Therefore, if the inlet gradient is excessive compared to channel gradient upstream of the crossing, the site will be designated as GRAY until hydraulic analysis can be completed for the site.

Evaluation Categories

The following categories will be used to classify crossings for juvenile and adult cutthroat and Bull trout for Region 1:

CHANNEL SIMULATION: Conditions assumed to be passable for all species/life stages.

GREEN: Conditions assumed adequate for passage of the analysis species life stage.

GREY: Conditions may not be adequate for the analysis species life stage presumed present. Additional analysis is required to determine the extent of barrier. It is here where we would denote possible flow barriers using hydraulic analysis.

RED: Conditions do not meet passage criteria at all desired flows for the analysis species life stage; assumed to be a barrier for that life stage.

It is important to note that fish may be able to pass through a number of the culverts identified in the RED and GREY categories during portions of the year, i.e. the culvert may actually be only a partial (flow) barrier. However, passage may only be possible during a very discrete period. The primary concern is that passage may not be possible for a particular life stage during the more extreme flow periods and most important migration times of the year such as during spring runoff and low base flows.

The passage evaluation criteria flowcharts do not cover all possible scenarios, thus the inventory data need to be thoroughly reviewed for any unique passage problems that may exist at crossings initially categorized as CHANNEL SIMULATION or GREEN. For example, a crossing may meet all flowchart criteria for passage but may still have an inlet drop, significant debris or sediment blockage, or a break within the structure itself. Further manual data review will identify and redefine these crossings appropriately.

Juvenile salmonid fish passage evaluation criteria at flows less than bankfull flows (developed by Region 1)

(NOT INTENDED TO BE USED FOR DESIGNING NEW STRUCTURES)

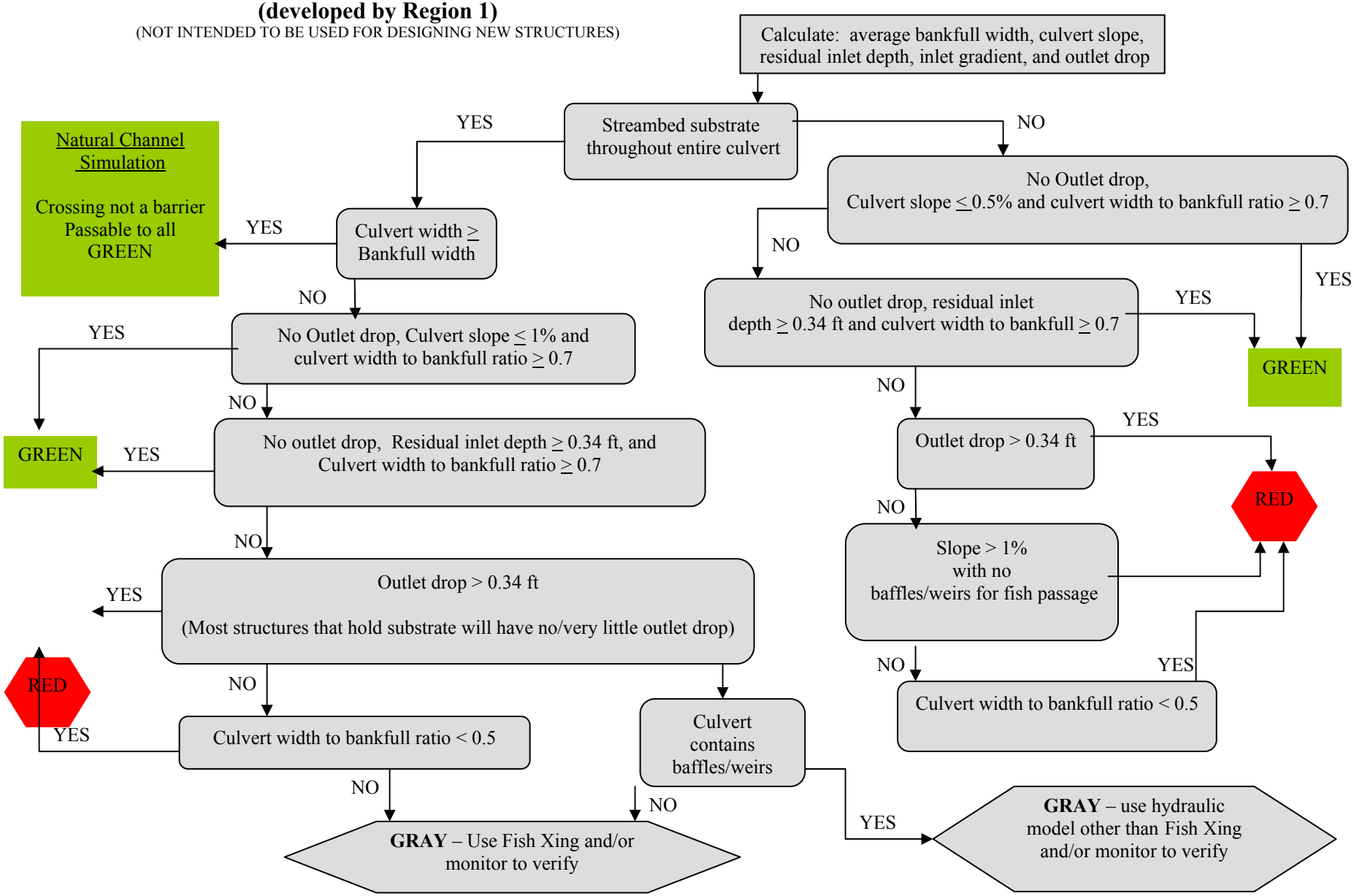


Figure 1. Fish passage evaluation criteria for juvenile salmonids (developed by USDA Forest Service Region 1).

Adult salmonid fish passage evaluation criteria developed by Region 1

(NOT INTENDED TO BE USED IN DESIGNING NEW STRUCTURES)

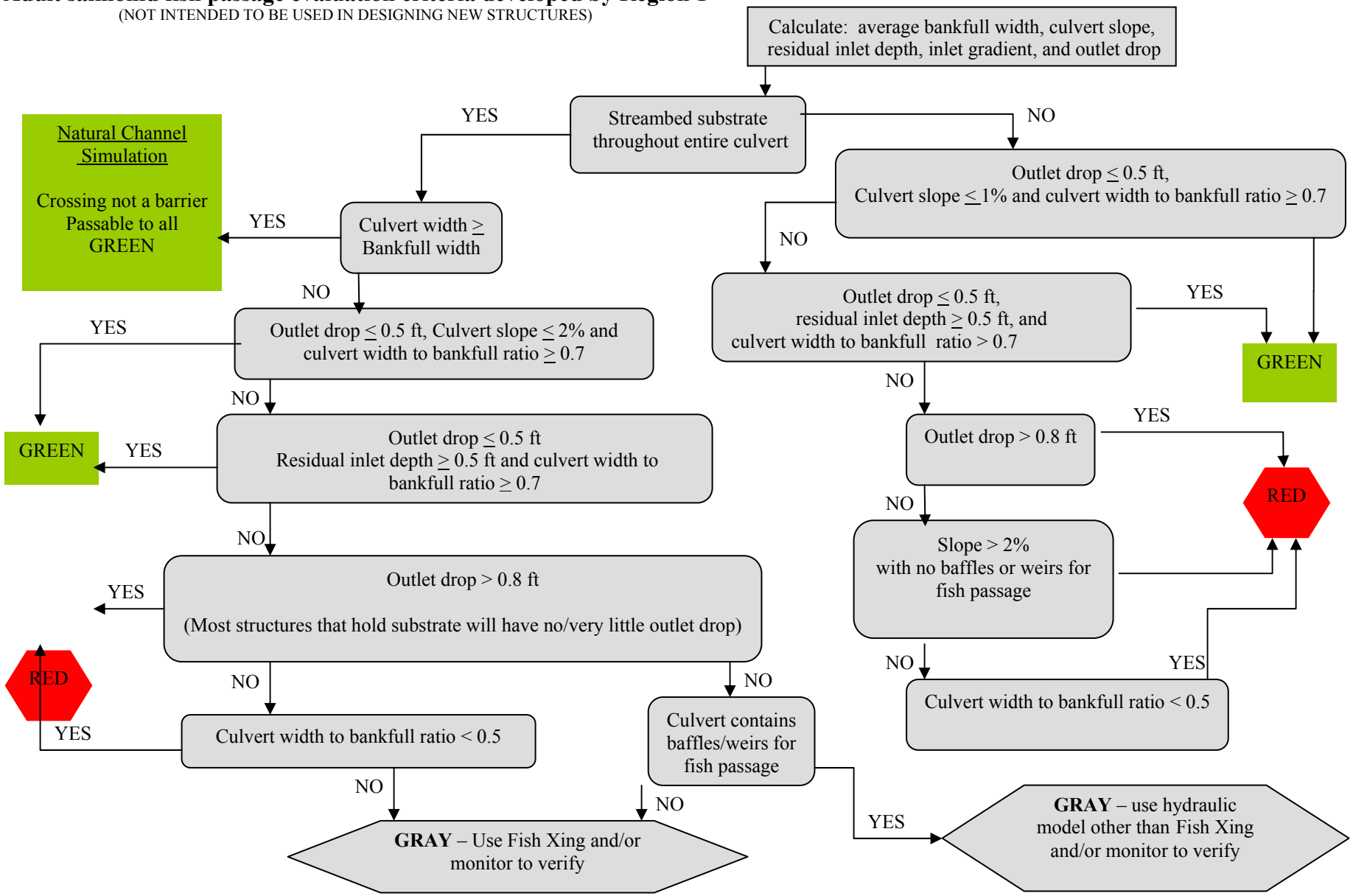


Figure 2. Fish passage evaluation criteria for adult salmonids (developed by USDA Forest Service Region 1).

Assumptions for Determining Miles of Blocked Habitat

The location of each culvert was used to determine how many miles were blocked or accessible. If the culvert was a barrier, the distance up to the next impassable culvert, a natural barrier, or end of fishes' distribution was considered blocked to fish below the culvert. Fish surveys and extent of perennial stream designations were used to approximate miles blocked. These distances were then summarized per resident juvenile and adult to represent total miles of stream blocked by life stage. Miles accessible within those subwatersheds surveyed were also totaled.

It was assumed that if a fish occurred above a culvert identified as a barrier, it was either a resident life history fish belonging to a populations isolated by the culvert, or an adult or offspring fluvial/adfluvial fish that, at certain flow conditions, could migrate through it.

In situations where a fish distribution occurred up to or slightly downstream of a culvert and not upstream, it was assumed that the culvert was a complete barrier to both juveniles and adults. It was also assumed that the species downstream had the potential to colonize habitat above the culvert to where a natural fish barrier occurred if the culvert was treated.

Table 10: Total Crossing Inventory Summary

Assessment Type	Count
Full Crossing Assessments	86
Partial Crossing Assessments	244
Inaccessible/ Bogus Sites	0
Total	**330**

Full Crossing = those crossings that were inventoried using entire protocol. Partial Crossing = those crossings that were inventoried just to make note of characteristics, but not considered a barrier. Inaccessible/ Bogus Sites = those crossings that did not actually exist in the field or were not accessible due to the road being overgrown or closed permanently.

Results

The majority of culverts (73% for adults and 81% for juveniles) in the fifteen 4th field subbasins surveyed rated out in the RED category (Table 1, Appendix A). Most of these pipes are circular or squashed pipe-arches, which occur in headwater tributaries (Table 3). All of the inventories were completed in the following subbasins as seen in Appendix A:

1. Central Bear
2. Bear Lake
3. Middle Bear
4. Little Bear – Logan
5. Lower Bear – Malad
6. Palisades
7. Salt
8. Upper Henrys
9. Teton
10. Willow
11. Blackfoot
12. Portneuf
13. Lake Walcott
14. Beaver - Camas
15. Medicine Lodge

In 2005, the majority of the barriers or "RED" culverts were found in the Bear Lake, Salt River, and Palisades subbasins, respectively (Appendix A and B). Each culvert was evaluated by calculating the parameters necessary to move through the flowcharts (Figures 1 & 2). Table 11 summarizes the first trigger for determining the crossing to be a barrier as defined through the flowchart. Outlet drop is the first trigger as encountered in the flowchart and also was the number 1 reason for the crossing to be a barrier on the Caribou-Targhee National Forest. Outlet drop defined the first barrier that a fish swimming upstream would encounter at that particular crossing even though there may be other

reasons that the fish cannot move past the crossing if they were to swim past the outlet drop. Outlet drop defined the barrier in 58% of the crossings surveyed for adults, followed by 34% for culvert slope, and 4% for inlet/channel ratio. For juveniles, outlet drop defined the barrier in 66% of the crossings surveyed while culvert slope made up about 27% and inlet/channel ratio made up 4%.

Table 11: Summary of Barrier Triggers

"RED" Crossing Assessment	Outlet Drop	Culvert Slope	Inlet/ Channel Ratio	Other	Total
Adult	29	20	14	0	63
Juvenile	40	25	5	0	70

This table illustrates a summary of the crossings found to be a barrier (RED) and the trigger or first reason the crossing structure presented a barrier. Outlet drop, culvert slope, and inlet/channel ratio were the primary barrier mechanisms. As illustrated, unacceptable outlet drops were attributed to crossing barriers 46% for adults and 57% for juveniles, eliminating fish from even entering the culvert. Additionally, 40% of the crossings surveyed had unacceptable inlet/channel ratios.

The majority of surveyed culverts have impacted both Bonneville and Yellowstone cutthroat trout populations by fragmenting populations and blocking access to suitable habitat.

On the Caribou-Targhee N.F., YCT are substantially more impacted by road crossings than BCT due to their larger geographical range on the Forest. In the five 4th level HUC subbasins occupied by BCT, 19 full and 64 partial assessments were conducted, while the majority of survey effort was spent conducting 67 full and 180 partial assessments in the 10 4th level HUC subbasins occupied by YCT (Table 1, Appendix A). Survey results determined that of the 86 complete assessments that were rated twice (for juvenile and adult passage requirements), 77% of these crossing sites do not meet the criteria to pass fish (RED) (Table 1). On YCT stronghold streams these crossings block approximately 154 miles of habitat for juveniles and 149 miles of habitat for adult YCT. In comparison, less than a mile is blocked for adults and approximately 3 miles are blocked for juveniles on BCT stronghold streams (Table 5, Appendix A). Quantities of open (GREEN) and potentially blocked (GREY) stream miles, for BCT and YCT stronghold streams, are listed in Tables 3 and 4 of Appendix A.

Table 12: Summary of Partial Assessments and the Crossing Types Encountered

Crossing Type	Crossing Count
Circular Culvert	122
Bridge	71
Ford	37
Pipe Arch	8
Foot Bridge	3
Box Culvert	2
Open Bottom Arch	1
Total	244

This table represents a summary of the types of crossings that were encountered by field crews and given partial crossing assessments. While important data was collected, these sites were not given further consideration for fish passage issues.

On water quality impaired streams (303(d)) approximately 110 miles for adults and 126 miles for juveniles are blocked by barrier culverts (Table 8, Appendix A). Quantities of open (GREEN) and potentially blocked (GREY) stream miles, for 303(d) streams, are listed in Tables 6 and 7 of Appendix A. Treatment of problem culverts on water quality impaired streams (303(d)) could generate positive effects for fish populations, channel stability, and water quality.

Tabulated miles of accessible, partially blocked, and blocked habitat, calculated from all full assessments, are displayed by 5th field watershed in Tables 3-8 in Appendix A and by individual crossings in Table 1 of Appendix B.

Proposal for Rehabilitation and Reconstruction

Recommendations

We have taken the results of this survey and focused on those crossings considered RED that are within BCT and YCT stronghold subbasins and on water quality impaired streams (303(d)). Priority was assigned mainly by calculating the miles of habitat available upstream from the crossing. Prioritization of culverts was divided into three lists to help narrow crossing replacement and restoration efforts according to biota and water quality status (Tables 4, 5, and 6). Note that some crossings are listed in multiple tables due to the nature that some streams are both cutthroat strongholds and impaired waters (303(d)).

The order of crossing to treat within Tables 4, 5 and 6 is according to the amount of suitable habitat upstream. This estimate was based on the miles of perennial aquatic habitat upstream of the crossing. Some perennial stream miles may not necessarily provide suitable fisheries habitat, but may provide habitat for other aquatic-dependent species.

Culvert replacement projects should be conducted in an interdisciplinary fashion to account for biological, social, and physical characteristics of that particular crossing. For example, some crossings that pose a barrier to upstream-migrating fish may be desirable to protect native fish upstream from non-native fish downstream of the crossing. In addition, the San Dimas Methodology used for this assessment was very conservative to account for the migratory abilities of all aquatic biota in the Forest Service System. A barrier identified through this methodology may not be an entire barrier to species our particular Forest is conserving.

Additional recommendations include surveying other crossings across the Forest, as funding allows, to fill data gaps for subbasins with depressed BCT and YCT populations. As illustrated in Table 2, the Caribou-Targhee National Forest has an estimated 1080 stream crossings that have not been assessed. The results from this report provide a compelling reason to evaluate the remaining crossings for all species, regardless of priority, because the data can assist in future restoration efforts.

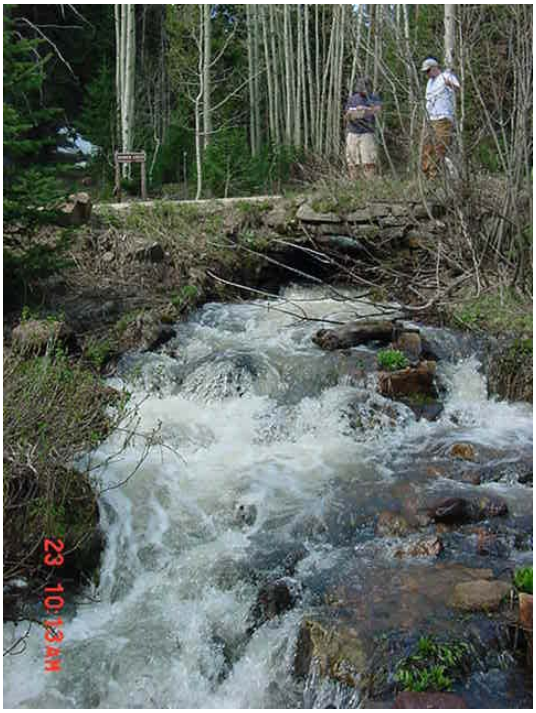
Top Restoration Sites

Of the 86 culverts that received the full assessments in 2005, the Forest has identified its top "RED" culverts needing replacement (Tables 4, 5, and 6). The top ten culvert replacements, for each category, are discussed below.

Top Bonneville Cutthroat Trout Sites

1. The first priority site is FS111-5.1 on Pruess Creek in the Pruess/Dry 5th field watershed of the Central Bear subbasin. This culvert is the only culvert crossing located on Pruess Creek on the Forest and blocks the most headwater mileage for culverts that ranked as being impassable (RED) to at least one life stage on BCT stronghold streams. Results from the survey determined that this

culvert is a barrier (RED) to juvenile BCT and not a barrier (GREEN) for adult BCT. This culvert is known to block approximately 2.62 miles of stream habitat to juvenile movement. Problems associated with juvenile BCT movement at this crossing include outlet drop and lack of backwatering at the outlet. Pruess Creek is considered a BCT stronghold on the Caribou-Targhee National Forest and as a water quality impaired stream by the State of Idaho. Replacement of this culvert will benefit resident fish movement and may contribute to enhanced water quality.



2. The second priority site is FS403-1.0 on South Skinner Creek in the Rattlesnake 5th field watershed of the Bear Lake subbasin. This was the first culvert encountered by the crew on the Forest and the only full assessment conducted on South Skinner Creek. Above this crossing, three partial assessments were conducted at one road crossing. These culverts (two overflow and one in the main channel) were not fully assessed due to stream channel gradients that appeared to be over 20%. This culvert is a barrier (RED) to both life stages of BCT and blocks approximately 0.38 miles of potential headwater habitat. Problems associated with this culvert include culvert slope, and steep channel gradients above and below the structure. South Skinner Creek is considered a BCT stronghold by the Caribou-Targhee National Forest. Replacement of this culvert will benefit fish movement.

Top Yellowstone Cutthroat Trout Sites

1. The first priority site is HWY34-3.3 on Tincup Creek in the Tincup 5th field watershed of the Salt subbasin. Six crossings, requiring eight full assessments, were conducted on Tincup Creek. This culvert is located the furthest upstream on Tincup Creek and blocks the most headwater habitat for culverts that ranked as being impassable (RED) on YCT stronghold streams. This culvert is a barrier to both life stages of YCT and blocks approximately 24.35 miles of headwater habitat. Problems associated with this crossing include outlet drop, inadequate culvert to bankfull width ratio, and lack of backwatering at the outlet. Tincup Creek is considered an YCT stronghold on the Caribou-Targhee National Forest. Replacement of this culvert would make the headwaters habitat more accessible to YCT.

2. The second priority site is FS058-1.9 on Elk Creek in the Bear 5th field watershed of the Palisades subbasin. This culvert is located approximately 2 miles upstream from Palisades Reservoir. This culvert is a barrier (RED) to both life stages of YCT and blocks approximately 12.87 miles of potential headwater habitat. Problems associated with this culvert include outlet drop, culvert slope, inadequate culvert to bankfull width ratio, and lack of backwatering at the outlet. Elk Creek is considered a YCT stronghold by the Caribou-Targhee N.F. and as a water quality impaired stream by the State of Idaho. Replacement of this culvert will benefit resident and adfluvial fish movement and may contribute to enhanced water quality by increasing channel stabilty.

3. The third priority site is FS175-0.10 and FS175-0.11 on Horseshoe Creek in the Mahogany 5th field watershed of the Teton subbasin. At this crossing dual culverts were surveyed. One culvert was determined to be a passage barrier (RED) to both life stages, and the other culvert was rated as being a possible barrier (GREY) to both life stages and needing further evaluation. Together these culverts block approximately 11.93 miles of headwater habitat for YCT. Problems associated with these structures include outlet drop, culvert slope, and lack of backwatering at the outlet. Horseshoe Creek is a YCT stronghold stream and is also listed by the state of Idaho as water quality impaired (303d). Replacement of this culvert would make the headwaters habitat more accessible to YCT and may contribute to enhanced water quality through increasing channel stability.

4. The fourth priority site is HWY34-5.30 and HWY34-5.31 on Tincup Creek in the Tincup 5th field watershed of the Salt subbasin. Six crossings, requiring eight full assessments, were conducted on Tincup Creek. This culvert was the second culvert surveyed as you move upstream. The crossing located approximately 0.5 miles below this site is similar in size and design (both sites contain dual culverts) and, like this structure, was determined to be a barrier (RED) to both life stages of YCT. Together, these culverts block approximately 11.79 miles of headwater habitat for YCT. Problems associated with

these crossings include outlet drop, culvert slope, and lack of backwatering at the outlet. Tincup Creek is considered an YCT stronghold on the Caribou-Targhee National Forest. Replacement of this culvert would make the headwaters habitat more accessible to YCT.

5. The fifth priority site is FS087-0.1 on McCoy Creek in the McCoy 5th field watershed of the Palisades subbasin. This was the first culvert encountered and the only full assessment conducted on McCoy Creek. This culvert is located approximately 10 miles west of the confluence with Palisades Reservoir and three bridges (partial assessments) were located in this stretch. This structure was determined to be a barrier (RED) to both life stages of YCT and blocks an estimated 11.76 miles up headwater habitat. Problems associated with this crossing include culvert slope, outlet drop, lack of backwatering at the outlet, and inadequate culvert to bankfull width ratio. McCoy Creek is an YCT stronghold stream on the Caribou-Targhee National Forest and is also listed by the State of Idaho as water quality impaired (303d). Replacement of this culvert would make the headwaters habitat more accessible to migratory YCT and may contribute to enhanced water quality.

6. The sixth priority site is FS178-2.8 on Crooked Creek in the Grouse Canyon 5th field watershed of the Medicine Lodge subbasin. Crooked Creek is part of the Sinks drainage. This crossing was the first culvert fully assessed and the third culvert encountered as you move upstream. At the first two culverts in the system, partial assessments were conducted due to the condition of the channel. Crooked Creek has been diverted out of its natural channel for quite some time. This is apparent through the amount of riparian vegetation surrounding the new channel. The diverted channel occurs from the FS boundary up until the drainage narrows about 0.5 miles above this structure location. This diversion channel resembles a straight, box-shaped ditch with the only fish habitat components provided by the any available riparian vegetation. Fish were seen near this crossing. This structure was determined to be a barrier (RED) to both life stages of YCT and blocks an estimated 9.15 miles of headwater habitat. Problems associated with this crossing include lack of backwatering at the outlet and inadequate culvert to bankfull width ratio. Crooked Creek is a YCT stronghold stream on the Caribou-Targhee National Forest. Replacement of this culvert would make the headwaters habitat more accessible to YCT.

7. The seventh priority site is FS161-0.01 on Indian Creek in the Indian 5th field watershed of the Palisades subbasin. This was the only culvert

encountered and assessment conducted on Indian Creek. This culvert is located less than a mile from the confluence with the South Fork of the Snake River. This structure was determined to be a barrier (RED) to both life stages of YCT and blocks an estimated 6.78 miles of headwater habitat. Problems associated with this crossing include outlet drop, culvert slope, and lack of backwatering at the outlet. Indian Creek is a YCT stronghold stream on the Caribou-Targhee National Forest. Replacement of this culvert would make the headwaters habitat more accessible to YCT.

8. The eighth priority site is FS087-1.7 on Burns Creek in the Burns Canyon 5th field watershed of the Salt subbasin. This was the only culvert encountered during the assessment of Burns Creek. This culvert is located less than 0.25 miles from the confluence with the Salt River. This structure was determined to be a barrier (RED) to both life stages of YCT and blocks an estimated 5.27 miles of headwater habitat. Problems associated with this crossing include outlet drop, culvert slope, lack of backwatering at the outlet, and inadequate culvert to bankfull width ratio. Burns Creek is a YCT stronghold stream on the Caribou-Targhee National Forest. Replacement of this culvert is scheduled for the summer of 2006 and would make the headwaters habitat more accessible to migratory YCT.

9. The ninth priority site is FS195-1.0 on North Fork of Fritz Creek in the Divide 5th field watershed of the Medicine Lodge subbasin. Fritz Creek is considered to be part of the Sinks drainage. This was the only culvert encountered in the North Fork of Fritz Creek. Partial assessments were conducted, within the drainage, at two fords located on the main stem and one on the South Fork. This culvert is located less than 1.25 miles above the confluence with the South Fork of Fritz Creek on the North Fork of Fritz Creek. This structure was determined to be a barrier (RED) to both life stages of YCT and blocks an estimated 5.01 miles of headwater habitat. Problems associated with this crossing include culvert slope and inadequate culvert to bankfull width ratio. Fritz Creek and its forks are considered YCT stronghold streams on the Caribou-Targhee National Forest. Replacement of this culvert would make the headwaters habitat more accessible to migratory YCT.

10. The tenth priority site is FS524-0.1 on East Fork of Mink Creek in the Mink 5th field watershed of the Portneuf subbasin. This was the only culvert that received a full assessment on the East Fork of Mink Creek. However five partial assessments were conducted below this crossing at three bridges, one ford, and one culvert. These partial assessments were all clustered within a 0.5 mile span located on the East Fork, above the confluence with Mink Creek. The one culvert located downstream was partially assessed due to its location within a private land in-holding. This crossing should be assessed before any action occurs on this stream. One crossing was fully assessed on the main stem of Mink Creek (FS515-0.15), but it was located above the confluence with the East Fork. This crossing is located less than 2.0 miles above the confluence with Mink Creek on the East Fork of Mink Creek. Mink Creek is a tributary of the Portneuf River. This structure was determined to be a barrier (RED) to both life stages of YCT and blocks an estimated 4.64 miles of headwater habitat. Problems associated with this crossing include culvert slope and lack of backwatering at the outlet. The East Fork of Mink Creek is considered a YCT stronghold stream on the Caribou-Targhee National Forest. Replacement of this culvert would make the headwaters habitat more accessible to migratory YCT.

Top Impaired Water – 303(d) Sites

1. The first priority site is FS058-1.9 on Elk Creek in the Bear 5th field watershed of the Palisades subbasin. This culvert is located approximately 2.0 miles upstream from Palisades Reservoir. This was the only full assessment conducted although two bridges were partially assessed below this crossing on Elk Creek. This culvert is a barrier to both life stages of YCT and blocks approximately 12.87 miles of potential headwater habitat. Problems associated with this culvert include outlet drop, culvert slope, inadequate culvert to bankfull width ratio, and lack of backwatering at the outlet. Elk Creek is considered a YCT stronghold by the Caribou-Targhee National Forest and as a water quality impaired stream (303(d)) by the State of Idaho. Replacement of this culvert will benefit fish movement and may contribute to enhanced water quality.

2. The second priority site is FS175-0.10 and FS175-0.11 on Horseshoe Creek in the Mahogany 5th field watershed of the Teton subbasin. At this crossing dual culverts were surveyed. One culvert was determined to be a passage barrier (RED) to both life stages, and the other culvert was rated as being a possible barrier (GREY) to both life stages and needing further evaluation. Together these culverts block approximately 11.93 miles of headwater habitat for YCT. Problems associated with these structures include outlet drop, culvert slope, and lack of backwatering at the outlet. Horseshoe Creek is a YCT stronghold stream and is also listed by the State of Idaho as water quality impaired (303(d)). Replacement of this culvert would make the headwaters habitat more accessible to resident YCT and may contribute to enhanced water quality.

3. The third priority site is FS087-0.1 on McCoy Creek in the McCoy 5th field watershed of the Palisades subbasin. This was the first culvert encountered and the only full assessment conducted on McCoy Creek. This culvert is located approximately 10 miles west of the confluence with Palisades Reservoir and three bridges (partial assessments) were located in this stretch. This structure was determined to be a barrier to both life stages of YCT and blocks an estimated 11.76 miles up headwater habitat. Problems associated with this crossing include culvert slope, outlet drop, lack of backwatering at the outlet, and inadequate culvert to bankfull width ratio. McCoy Creek is a YCT stronghold stream on the Caribou-Targhee National Forest and is also listed by the State of Idaho as water quality impaired (303(d)). Replacement of this culvert would make the headwaters habitat more accessible to migrating YCT and may contribute to enhanced water quality.

4. The fourth priority site is FS515-0.15 on Mink Creek in the Mink 5th field watershed of the Portneuf subbasin. This was the only culvert that received a full assessment on Mink Creek. However partial assessments of three bridges on Mink Creek and 5 culverts on the South Fork of Mink Creek were conducted. These crossings were all located above this structure. This crossing is located less than 1.0 mile above the confluence with East Fork Mink Creek on Mink Creek. Mink Creek is a tributary of the Portneuf River. This structure was determined to be a barrier to both life stages of YCT and blocks an estimated 9.06 miles of headwater habitat. Problems associated with

this crossing include outlet drop, culvert slope, and lack of backwatering at the outlet. Mink Creek is listed by the State of Idaho as water quality impaired (303(d)). Replacement of this culvert would make the headwaters habitat more accessible to resident and fluvial YCT and may contribute to enhanced water quality.

5. The fifth priority site is FS149-0.1 on Montpelier Creek in the Montpelier 5th field watershed of the Bear Lake subbasin. This culvert is located approximately 0.5 miles above the FS Boundary and is below Montpelier Reservoir. Montpelier Dam is impassable to upstream-migrating fish. Results from the surveys determined that this culvert is a barrier (RED) to juvenile BCT. Passage ability has not been determined (GREY) for adult BCT. This culvert is known to block approximately 2.5 miles of stream habitat to juvenile movement. Another impassable culvert exists approximately 2.5 miles upstream of this culvert. Problems associated with this structure include outlet drop, inadequate culvert to bankfull ratio, and lack of backwatering at the outlet. Montpelier Creek is listed by the State of Idaho as a water quality impaired stream (303(d)). Replacement of this culvert would make the headwaters habitat more accessible to resident BCT and may contribute to enhanced water quality.

6. The sixth priority site is US89-0.01 on Montpelier Creek in the Montpelier 5th field watershed of the Bear Lake subbasin. This culvert is located approximately 3.0 miles above the FS Boundary and is below Montpelier Reservoir. Montpelier Dam is impassable to upstream-migrating fish. This culvert is a barrier (RED) to both life stages of BCT and blocks approximately 7.35 miles of stream habitat. Problems associated with this structure include outlet drop, inadequate culvert to bankfull ratio, and lack of backwatering at the outlet. Montpelier Creek is listed by the State of Idaho as a water quality impaired stream (303(d)). Replacement of this culvert would increase connectivity of stream reaches downstream of the dam.

7. The seventh priority site is FS256-0.40 and FS256-0.45 on North Moody Creek in the Moody 5th field watershed of the Teton subbasin. This crossing was the only full assessment conducted on North Moody Creek although two fords were partially assessed below this structure. At this crossing dual culverts were fully assessed and both found to be barriers (RED) to both life stages of YCT. Together these culverts block approximately 6.87 miles of headwater habitat for YCT. Problems associated with these structures include culvert slope, and lack of backwatering at the outlet. North Moody Creek is listed by the State of Idaho as water quality impaired (303(d)). Replacement of this culvert would make the headwaters habitat more accessible to resident YCT and may contribute to enhanced water quality.

8. The eighth priority site is FS102-2.8 on Georgetown Creek in the Georgetown 5th field watershed of the Bear Lake subbasin. This crossing was the only full assessment conducted on Georgetown Creek, although two culverts below this site and five culverts above this site were partially assessed. Georgetown Creek received so many partial assessments due to water management issues that have affected the flow. I suggest further analysis of this drainage to determine management issues that need to be addressed and actual available habitat above the barrier. This assessment determined that this culvert is a barrier (RED) to both life stages of BCT and blocks approximately 6.52 miles of stream habitat. Problems associated with this structure include outlet drop, culvert slope, and inadequate culvert to bankfull width ratios. Georgetown Creek is listed by the State of Idaho as water quality impaired (303(d)). Replacement of this culvert would make the headwaters habitat more accessible to resident BCT and may contribute to enhanced water quality.

9. The ninth priority site is FS086-0.01 on Corral Creek in the Brockman 5th field watershed of the Willow subbasin. This crossing was the only full assessment conducted on Corral Creek. Corral Creek is a tributary to Brockman Creek which is also listed by the State of Idaho as water quality impaired (303(d)). Results from the surveys determined that this culvert is a barrier (RED) to juvenile YCT and passage ability has not been determined (GREY) for adult YCT. This culvert is known to block approximately 3.59 miles of stream habitat to juvenile movement. Problems associated with this structure include culvert slope, and lack of backwatering at the outlet.

Corral Creek is listed by the state of Idaho as water quality impaired (303(d)). Replacement of this culvert would make the headwaters habitat more accessible to YCT and may contribute to enhanced water quality.

10. The tenth priority site is FS802-0.05 on the North Fork of Horseshoe Creek in the Mahogany 5th field watershed of the Teton subbasin. This crossing was the first culvert encountered when moving upstream. Three other full assessments and one partial assessment at a culvert were also conducted above this crossing on the North Fork of Horseshoe Creek. Results from the surveys determined that this culvert is a barrier (RED) to both life stages of YCT and blocks approximately 3.51 miles of stream habitat. Problems associated with this structure include outlet drop, culvert slope, and lack of backwatering at the outlet. The North Fork of Horseshoe Creek is a YCT stronghold stream on the Caribou-Targhee National Forest and is also listed by the State of Idaho as water quality impaired (303(d)). Replacement of this culvert would make the headwaters habitat more accessible to migrating YCT and may contribute to enhanced water quality.

Bibliography

Belford, D. A., and W. R. Gould, 1989, An evaluation of trout passage through six highway culverts in Montana. North American Journal of Fish Management 9(4): 437-445.

Burton, T, 1998, Protocol for Assessing Fish Passage at Culverts for the Boise National Forest. Boise NF, unpublished manuscript, 6 pp.

California Department of Fish and Game, 2001, Culvert Criteria for Fish Passage.

California Department of Fish and Game, 1998, California Salmonid Stream Habitat Restoration Manual, 3rd Edition, Part X Fish Passage Evaluation At Road Crossings.

Idaho Department of Lands Forester Forum, July 1998, Fish Passage Guidelines When Installing Stream Crossings. Forest Practices No 12, Boise, ID, 8 pp.

National Marine Fisheries Service, Southwest Region September 2001, Guidelines for Salmonid Passage at Stream Crossings. Santa Rosa, CA, 14 pp.

Robison, G.E., A. Mirati, and M. Allen, 1999, Oregon Road/Stream Crossing Restoration Guide: Spring 1999, Advanced Fish Passage Training Version.

Thompson, K, 1972, Determining stream flows for fish life. Pages 31-50 in Proceedings, instream flow requirements workshop. Pacific Northwest River Basins Commission, Vancouver, Washington.

Warren, M.L., and M.G. Pardew, 1998, Road Crossings as Barriers to Small Stream Fish Movement Trans Am Fisheries Soc 127:637-644.

Washington State Department of Fish and Wildlife Habitat Program, SSHEAR section. August 2000, Fish Passage Barrier and surface water Diversion Screening Assessment and Prioritization Manual.

Appendix A – Inventory Data by Hydrologic Unit

Table 1. Summary of Culvert Inventory and Assessment Type by 4th Field Subbasin

HUC4CODE	HUC4NAME	# Full Assessments	# Partial Assessments	Total
16010102	Central Bear	1	4	5
16010201	Bear Lake	15	39	54
16010202	Middle Bear	0	6	6
16010203	Little Bear - Logan	3	5	8
16010204	Lower Bear – Malad	0	10	10
17040104	Palisades	12	36	48
17040105	Salt	16	26	42
17040202	Upper Henrys	4	17	21
17040204	Teton	8	29	37
17040205	Willow	3	2	5
17040207	Blackfoot	4	22	26
17040208	Portneuf	9	29	38
17040209	Lake Walcott	0	1	1
17040214	Beaver - Camas	4	4	8
17040215	Medicine Lodge	7	14	21
Grand Total		**86**	**244**	**330**

Table 2. Summary of Lifestage Passage Assessment Barriers Color Coding by 4th Field Subbasin								
HUC 4 Code	**HUC 4 Name**	**# Adult RED**	**# Adult GRAY**	**# Adult GREEN**	**# Juvenile RED**	**# Juvenile GRAY**	**# Juvenile GREEN**	**Grand Total**
16010102	Central Bear	0	0	1	1	0	0	**1**
16010201	Bear Lake	13	1	1	13	2	0	**15**
16010203	Little Bear - Logan	2	1	0	3	0	0	**3**
17040104	Palisades	8	3	1	10	2	0	**12**
17040105	Salt	12	2	2	13	1	2	**16**
17040202	Upper Henrys	4	0	0	4	0	0	**4**
17040204	Teton	7	1	0	7	1	0	**8**
17040205	Willow	0	1	2	1	2	0	**3**
17040207	Blackfoot	1	2	1	1	2	1	**4**
17040208	Portneuf	5	2	2	6	3	0	**9**
17040214	Beaver - Camas	4	0	0	4	0	0	**4**
17040215	Medicine Lodge	7	0	0	7	0	0	**7**
Grand Total		**63**	**13**	**10**	**70**	**13**	**3**	**86**

Table 3. Miles of Accessible Habitat (Green) for Juveniles and Adults on BCT and YCT Stronghold Streams on the Caribou-Targhee National Forest.

4th Field Subbasin	5th Field Watershed	# Green Culverts	Accessible Miles	# Green Culverts	Accessible Miles
		Resident Juveniles		Resident Adults	
Central Bear	Pruess/Dry (1601010205)	0	--	1	2.62
Bear Lake	Rattlesnake (1601020103)	0	--	0	--
BCT Grand Total		**0**	**0**	**1**	**2.62**
Palisades	Burns Canyon (1704010401)	0	--	0	--
	Indian (1704010406)	0	--	0	--
	Bear (1704010409)	0	--	0	--
	Palisades Res (1704010410)	0	--	0	--
	McCoy (1704010411)	0	--	0	--
Salt	Burns Canyon (1704010500)	0	--	0	--
	Upper Crow (1704010507)	0	--	0	--
	Stump (1704010508)	0	--	0	--
	Tincup (1704010509)	2	3.65	2	3.65
	Jackknife (1704010510)	0	--	0	--
Upper Henrys	Sheridan (1704020208)	0	--	0	--
	Jesse (1704020210)	0	--	0	--
	Targhee (1704020212)	0	--	0	--
Teton	Mahogany (1704020409)	0	--	0	--
Blackfoot	Lanes (1704020711)	1	0.75	1	0.75
	Diamond (1704020712)	0	--	0	--
Portneuf	Mink (1704020802)	0	--	0	--
	Indian (1704020803)	0	--	0	--
	Bell Marsh (1704020804)	0	--	0	--
Beaver - Camas	Dry (1704021404)	0	--	0	--
Medicine Lodge	Grouse Canyon (1704021503)	0	--	0	--
	Divide (1704021505)	0	--	0	--
	Middle (1704021506)	0	--	0	--
YCT Grand Total		**3**	**4.40**	**3**	**4.40**

Table 4. Miles of Grey Habitat for Juveniles and Adults on BCT and YCT Stronghold Streams on the Caribou-Targhee National Forest.

4th Field Subbasin	5th Field Watershed	# Grey Culverts	Partially Blocked Miles	# Grey Culverts	Partially Blocked Miles
		Resident Juveniles		Resident Adults	
Central Bear	Pruess/Dry (1601010205)	0	--	0	--
Bear Lake	Rattlesnake (1601020103)	0	--	0	--
BCT Grand Total		**0**	**0**	**0**	**0**
Palisades	Burns Canyon (1704010401)	0	--	1	1.73
	Indian (1704010406)	0	--	0	--
	Bear (1704010409)	0	--	0	--
	Palisades Res (1704010410)	0	--	0	--
	McCoy (1704010411)	0	--	0	--
Salt	Burns Canyon (1704010500)	0	--	0	--
	Upper Crow (1704010507)	0	--	0	--
	Stump (1704010508)	0	--	0	--
	Tincup (1704010509)	0	--	0	--
	Jackknife (1704010510)	1	0.51	2	3.32
Upper Henrys	Sheridan (1704020208)	0	--	0	--
	Jesse (1704020210)	0	--	0	--
	Targhee (1704020212)	0	--	0	--
Teton	Mahogany (1704020409)	1	11.93	1	11.93
Blackfoot	Lanes (1704020711)	0	--	0	--
	Diamond (1704020712)	2	7.53	2	7.53
Portneuf	Mink (1704020802)	0	--	0	--
	Indian (1704020803)	1	4.65	1	4.65
	Bell Marsh (1704020804)	0	--	0	--
Beaver - Camas	Dry (1704021404)	0	--	0	--
Medicine Lodge	Grouse Canyon (1704021503)	0	--	0	--
	Divide (1704021505)	0	--	0	--
	Middle (1704021506)	0	--	0	--
YCT Grand Total		**5**	**24.62**	**7**	**29.16**

Table 5. Miles of Blocked Habitat (Red) for Juveniles and Adults on BCT and YCT Stronghold Streams on the Caribou-Targhee National Forest.

4th Field Subbasin	5th Field Watershed	# Red Culverts	Blocked Miles	# Red Culverts	Blocked Miles
		Resident Juveniles		Resident Adults	
Central Bear	Pruess/Dry (1601010205)	1	2.62	0	--
Bear Lake	Rattlesnake (1601020103)	1	0.38	1	0.38
BCT Grand Total		**2**	**3.00**	**1**	**0.38**
Palisades	Burns Canyon (1704010401)	4	8.47	3	6.74
	Indian (1704010406)	1	6.78	1	6.78
	Bear (1704010409)	1	12.87	1	12.87
	Palisades Res (1704010410)	1	6.33	1	6.33
	McCoy (1704010411)	2	14.04	2	14.04
Salt	Burns Canyon (1704010500)	1	5.27	1	5.27
	Upper Crow (1704010507)	1	1.92	1	1.92
	Stump (1704010508)	1	1.37	1	1.37
	Tincup (1704010509)	6	39.78	6	39.78
	Jackknife (1704010510)	4	6.39	3	3.58
Upper Henrys	Sheridan (1704020208)	1	3.19	1	3.19
	Jesse (1704020210)	1	0.35	1	0.35
	Targhee (1704020212)	1	1.25	1	1.25
Teton	Mahogany (1704020409)	5	18.13	5	18.13
Blackfoot	Lanes (1704020711)	0	--	0	--
	Diamond (1704020712)	1	1.42	1	1.42
Portneuf	Mink (1704020802)	1	4.64	1	4.64
	Indian (1704020803)	0	--	0	--
	Bell Marsh (1704020804)	2	2.09	2	2.09
Beaver - Camas	Dry (1704021404)	2	4.19	2	4.19
Medicine Lodge	Grouse Canyon (1704021503)	1	9.15	1	9.15
	Divide (1704021505)	1	5.01	1	5.01
	Middle (1704021506)	3	1.12	3	1.12
YCT Grand Total		**41**	**153.76**	**39**	**149.22**

Table 6. Miles of Accessible Habitat (Green) for Juveniles and Adults on Impaired Streams (303(d)) on the Caribou-Targhee National Forest.

4th Field Subbasin	5th Field Watershed	# Green Culverts	Accessible Miles	# Green Culverts	Accessible Miles
		Resident Juveniles		Resident Adults	
Central Bear	Pruess/Dry (1601010205)	0	--	1	2.62
Bear Lake	Sulfur Canyon (1601020102)	0	--	0	--
	Georgetown (1601020104)	0	--	0	--
	Montpelier (1601020105)	0	--	0	--
	Emigration (1601020106)	0	--	1	3.28
	Bloomington (1601020108)	0	--	0	--
Little Bear - Logan	Logan River (1601020303)	0	--	0	--
Palisades	Fall (1704010405)	0	--	1	41.98
	Bear (1704010409)	0	--	0	--
	McCoy (1704010411)	0	--	0	--
Upper Henrys	Targhee (1704020212)	0	--	0	--
Teton	Moody (1704020402)	0	--	0	--
	Mahogany (1704020409)	0	--	0	--
Willow	Brockman (1704020505)	0	--	2	9.06
Blackfoot	Diamond (1704020712)	0	--	0	--
Portneuf	Mink (1704020802)	0	--	0	--
	Bell Marsh (1704020804)	0	--	0	--
	Pebble (1704020809)	0	--	2	1.09
Beaver-Camas	Lava (1704021403)	0	--	0	--
Medicine Lodge	Grouse Canyon (1704021503)	0	--	0	--
Impaired Waters - 303(d) Grand Total		**0**	**0**	**7**	**58.03**

Table 7. Miles of Grey Habitat for Juveniles and Adults on Impaired Streams (303(d)) on the Caribou-Targhee National Forest.

4th Field Subbasin	5th Field Watershed	# Grey Culverts	Partially Blocked Miles	# Grey Culverts	Partially Blocked Miles
		Resident Juveniles		Resident Adults	
Central Bear	Pruess/Dry (1601010205)	0	--	0	--
Bear Lake	Sulfur Canyon (1601020102)	1	4.80	1	4.80
	Georgetown (1601020104)	0	--	0	--
	Montpelier (1601020105)	0	--	0	--
	Emigration (1601020106)	1	3.28	0	--
	Bloomington (1601020108)	0	--	0	--
Little Bear - Logan	Logan River (1601020303)	0	--	1	2.83
Palisades	Fall (1704010405)	2	42.89	2	4.69
	Bear (1704010409)	0	--	0	--
	McCoy (1704010411)	0	--	0	--
Upper Henrys	Targhee (1704020212)	0	--	0	--
Teton	Moody (1704020402)	0	--	0	--
	Mahogany (1704020409)	1	11.93	1	11.93
Willow	Brockman (1704020505)	2	9.06	1	3.59
Blackfoot	Diamond (1704020712)	1	5.34	1	5.34
Portneuf	Mink (1704020802)	0	--	0	--
	Bell Marsh (1704020804)	0	--	0	--
	Pebble (1704020809)	2	1.09	1	3.16
Beaver-Camas	Lava (1704021403)	0	--	0	--
Medicine Lodge	Grouse Canyon (1704021503)	0	--	0	--
Impaired Waters – 303(d) Grand Total		**10**	**78.39**	**8**	**36.34**

Table 8. Miles of Blocked Habitat (Red) for Juveniles and Adults on Impaired Waters (303(d)) on the Caribou-Targhee National Forest.

4th Field Subbasin	5th Field Watershed	# Red Culverts	Blocked Miles	# Red Culverts	Blocked Miles
		Resident Juveniles		Resident Adults	
Central Bear	Pruess/Dry (1601010205)	1	2.62	0	--
Bear Lake	Sulfur Canyon (1601020102)	1	1.95	1	1.95
	Georgetown (1601020104)	1	6.52	1	6.52
	Montpelier (1601020105)	3	19.12	3	19.12
	Emigration (1601020106)	6	9.04	6	9.04
	Bloomington (1601020108)	1	0.36	1	0.36
Little Bear - Logan	Logan River (1601020303)	3	5.95	2	3.12
Palisades	Fall (1704010405)	1	3.78	0	--
	Bear (1704010409)	1	12.87	1	12.87
	McCoy (1704010411)	1	11.76	1	11.76
Upper Henrys	Targhee (1704020212)	2	4.18	2	4.18
Teton	Moody (1704020402)	2	6.87	2	6.87
	Mahogany (1704020409)	5	18.13	5	18.13
Willow	Brockman (1704020505)	1	3.59	0	--
Blackfoot	Diamond (1704020712)	0	--	0	--
Portneuf	Mink (1704020802)	1	9.06	1	9.06
	Bell Marsh (1704020804)	2	2.09	2	2.09
	Pebble (1704020809)	2	4.96	1	1.80
Beaver-Camas	Lava (1704021403)	2	0.55	2	0.55
Medicine Lodge	Grouse Canyon (1704021503)	2	2.30	2	2.30
Impaired Waters – 303(d) Grand Total		**38**	**125.70**	**33**	**109.72**

Appendix B – Inventory Data by Stream

Table 1. Summary of All Fully Assessed Culverts by Stream and Inventory Priority. Both RED (Known Barriers) and GREY (Undetermined Barriers) Culverts For at Least One Life Stage are Listed With Approximate Miles of Blocked Habitat.

HUC5CODE	Stream Name	Crossing ID	Inventory Priority	Miles of Blocked Habitat Upstream	Perennial Miles Upstream
1601010205	Pruess Creek	FS111-5.1	BCT+303(d)	2.62	2.62
1601020102	Eightmile Creek	FS402-0.1	303(d)	1.95	6.75
1601020102	Eightmile Creek	FS425-0.8	303(d)	4.80	4.80
1601020103	South Skinner Creek	FS403-1.0	BCT	0.38	0.38
1601020104	Georgetown Creek	FS102-2.8	303(d)	6.52	6.52
1601020105	Montpelier Creek	FS149-0.1	303(d)	8.92	16.27
1601020105	Montpelier Creek	US89-0.01	303(d)	7.35	7.35
1601020105	Snowslide Canyon	FS111-3.8	303(d)	2.85	2.85
1601020106	North Creek	FS000-0.1	303(d)	1.64	9.04
1601020106	North Creek	FS401-0.40	303(d)	3.28	7.40
1601020106	North Creek	FS401-0.41	303(d)	3.28	7.40
1601020106	North Creek	FS401-2.2	303(d)	0.21	4.12
1601020106	North Creek	FS401-2.4	303(d)	0.11	3.91
1601020106	North Creek	FS401-2.5	303(d)	0.31	3.80
1601020106	North Creek	FS401-2.8	303(d)	3.49	3.49
1601020108	Paris Creek	FSPSC-1.4	303(d)	0.36	0.36
1601020303	Beaver Creek	FS411-3.3	303(d)	2.55	5.95
1601020303	Beaver Creek	FS411-0.75	303(d)	0.57	3.40
1601020303	Beaver Creek	FS411-0.15	303(d)	2.83	2.83
1704010401	Table Rock Creek	FS217-0.01	YCT	1.73	4.80
1704010401	Table Rock Creek	FS217-1.8	YCT	3.07	3.07
1704010401	Wolverine Creek	FS206-1.10	YCT	3.67	3.67
1704010401	Wolverine Creek	FS206-1.11	YCT	3.67	3.67
1704010405	Fall Creek	FS170-0.01	303(d)	0.91	46.67
1704010405	Fall Creek	FS077-7.6	303(d)	3.78	45.76
1704010405	Fall Creek	FS077-8.3	303(d)	41.98	41.98
1704010406	Indian Creek	FS161-0.01	YCT	6.78	6.78
1704010409	Elk Creek	FS058-1.9	YCT+303(d)	12.87	12.87

1704010410	Trout Creek***	FS087-3.5	YCT	6.33	6.33
1704010411	McCoy Creek	FS087-0.1	YCT+303(d)	11.76	11.76
1704010411	Miners Delight	FS087-3.1	YCT	2.28	2.28
1704010500	Burns Creek	FS087-1.7	YCT	5.27	5.27
1704010507	Deer Creek	FS102-1.3	YCT	1.92	1.92
1704010508	Flat Valley Creek	FS107-6.6	YCT	1.37	1.37
1704010509	Tincup Creek	HWY34-5.80	YCT	3.41	43.43
1704010509	Tincup Creek	HWY34-5.81	YCT	3.41	43.43
1704010509	Tincup Creek	HWY34-5.30	YCT	11.79	40.02
1704010509	Tincup Creek	HWY34-5.31	YCT	11.79	40.02
1704010509	Tincup Creek	HWY34-4.4	YCT	GREEN	0.15
1704010509	Tincup Creek	HWY34-4.3	YCT	GREEN	3.50
1704010509	Tincup Creek	HWY34-3.5	YCT	0.23	24.58
1704010509	Tincup Creek	HWY34-3.3	YCT	24.35	24.35
1704010510	Deep Creek	FS070-0.7	YCT	2.81	6.90
1704010510	Deep Creek	FS070-1.1	YCT	0.27	4.09
1704010510	Deep Creek	FS070-1.4	YCT	1.81	3.82
1704010510	Deep Creek	FS070-2.9	YCT	0.51	2.01
1704010510	Deep Creek	FS070-3.3	YCT	1.50	1.50
1704020208	West Dry Creek Trib	FS327-4.0	YCT	3.19	3.19
1704020210	Tygee Creek	FS061-6.9	YCT	0.35	0.35
1704020212	Howard Creek	FS057-0.01	YCT + temp	1.25	1.25
1704020212	South Fork Duck Cr.	FS053-2.8	303(d)	2.93	2.93
1704020402	North Moody Creek	FS256-0.40	303(d)	6.87	6.87
1704020402	North Moody Creek	FS256-0.45	303(d)	6.87	6.87
1704020409	Horseshoe Creek	FS175-0.10	YCT+303(d)	11.93	18.13
1704020409	Horseshoe Creek	FS175-0.11	YCT+303(d)	11.93	18.13
1704020409	North Fork Horseshoe	FS802-0.05	YCT+303(d)	3.51	6.20
1704020409	North Fork Horseshoe	FS235-1.7	YCT+303(d)	1.88	2.69
1704020409	North Fork Horseshoe	FS235-2.5	YCT+303(d)	0.08	0.81
1704020409	North Fork Horseshoe	FS235-2.4	YCT+303(d)	0.73	0.73
1704020505	Brockman Creek	FS077-3.90	303(d)	9.06	9.06

1704020505	Brockman Creek	FS077-3.91	303(d)	9.06	9.06
1704020505	Corral Creek	FS086-0.02	303(d)	3.59	3.59
1704020711	Browns Canyon	FS107-4.4	YCT	GREEN	0.75
1704020712	Bear Canyon	FS102-0.1	YCT	2.19	2.19
1704020712	Diamond Creek	FS102-1.4	YCT+303(d)	5.34	5.34
1704020712	Stewart Canyon	FS102-0.5	YCT	1.42	1.42
1704020802	East Fork Mink Creek	FS524-0.1	YCT	4.64	4.64
1704020802	Mink Creek	FS515-0.15	303(d)	9.06	9.06
1704020803	Inman Creek	FS018-0.15	YCT	4.65	4.65
1704020804	Goodenough Creek	FS541-2.90	YCT+303(d)	2.09	2.09
1704020804	Goodenough Creek	FS541-2.91	YCT+303(d)	2.09	2.09
1704020809	North Fork Pebble Cr.	FS036-1.3	303(d)	3.16	4.25
1704020809	North Fork Pebble Cr.	FS013-1.10	303(d)	1.09	1.09
1704020809	North Fork Pebble Cr.	FS013-1.11	303(d)	1.09	1.09
1704020809	Pebble Creek	FS024-0.5	303(d)	1.80	1.80
1704021403	Cow Creek	FS678-0.20	303(d)	0.55	0.55
1704021403	Cow Creek	FS678-0.21	303(d)	0.55	0.55
1704021404	Corral Creek	FS177-0.25	YCT	0.62	0.62
1704021404	West Fork Rattlesnake	FS021-1.5	YCT	3.57	3.57
1704021503	Crooked Creek	FS178-2.8	YCT	9.15	9.15
1704021503	Warm Springs Creek	FS198-0.1	303(d)	0.90	2.30
1704021503	Warm Springs Creek	FS198-1.0	303(d)	1.40	1.40
1704021505	North Fork Fritz Creek	FS195-1.0	YCT	5.01	5.01
1704021506	Corral Creek	FS323-0.1	YCT	0.86	1.12
1704021506	Corral Creek	FS323-0.15	YCT	0.86	1.12
1704021506	Corral Creek	FS323-1.0	YCT	0.26	0.26